

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

PYRHÖNEN

Art Unit: 2834

Application No.: 09/269,754

Examiner: T. Lam

Filed: April 7, 1999

Attorney Dkt. No.: 108306-09004

For: AN ELECTRIC MACHINE CONSTRUCTION AND METHOD FOR AN
ELECTRIC MACHINE

FAX RECEIVED

RESPONSE UNDER 37 C.F.R. § 1.121

NOV 20 2001

Commissioner for Patents
Washington, D.C. 20231

Date: September 11, 2001

T.C. 2800

Sir:

In reply to the outstanding Office Action dated April 11, 2001, having been duly extended from July 11, 2001, until September 11, 2001, by the attached Petition for Extension of Time, please amend the above-identified application as set forth below.

IN THE CLAIMS:

Please amend claims 1 and 8 as follows. Pursuant to 37 C.F.R. § 1.121, as amended, a copy of the marked-up version of original claims 1 and 8 is attached to this Response showing the changes made therein.

- D1*
SUB
E1
1. (Twice Amended) An electric machine construction, comprising:
a stator space defined by a shell and end portions at both ends of the shell,
a stator and a rotor having a first end and a second end disposed within said stator space, comprising
at least one cooling medium inlet opening in the shell and positioned intermediate the ends of the rotor,

*D1
conceded*
*SUB
E1
conceded*
a suction means at the vicinity of both end portions of the stator space for providing suction for drawing cooling medium into said stator space,

wherein said suction means are fans arranged at an interior side of the end portions of the stator space including rotor bearings, in which an outlet channel of said fans extends through the end portions, and

wherein the arrangement is such that the cooling medium is drawn by the suction into the stator space through said at least one inlet opening and that the cooling medium is removed at the vicinity of both portions of the stator space.

D2.
*SUB
E2*
8. (Twice Amended) A method for an electric construction, comprising a stator space defined by a shell and end portions at the either ends of the shell, wherein a stator and a rotor of the electric machine are disposed within the stator space, wherein cooling medium is drawn into the stator space through at least one cooling medium inlet opening in said shell intermediate the ends of the rotor by suction means for providing a suction, said suction means being provided at a vicinity of both end portions and are fans arranged at an interior side of the end portions of the stator space including rotor bearings, in which an outlet channel of said fans extends through the end portions, and the cooling medium is removed at the vicinity of both ends portions of the stator space.

REMARKS

The Office Action dated April 11, 2001, has been received and carefully noted. The period for response having been duly extended from July 11, 2001, until September 11, 2001, by the attached Petition for Extension of Time, the amendments made herein and the following remarks are submitted as a full and complete response thereto.

Claims 1 and 8 have been amended. No new matter has been added by the amendments made herein. Accordingly, claims 1-12 are pending in the present application and are respectfully submitted for consideration.

Claims 1-6 and 8-11 were rejected under 35 U.S.C. § 102(b) as being anticipated by Purman (U.S. Patent No. 3,805,101). Applicant respectfully traverses this rejection, and submits that each of claims 1-6 and 8-11 recites subject matter that is neither disclosed nor suggested by Purman.

Claim 1, upon which claims 2-7 are dependent, recites an electric machine construction comprising a stator space defined by a shell and end portions at both ends of the shell. The electric machine construction also comprises a stator and a rotor having a first end and a second end disposed within the stator space, comprising at least one cooling medium inlet opening in the shell and positioned intermediate the ends of the rotor, and a suction means at the vicinity of both end portions of the stator space for providing suction for drawing cooling medium into the stator space. The suction means are fans arranged at an interior side of the end portions of the stator space including rotor bearings, in which an outlet channel of said fans extends through the end portions. The arrangement is such that the cooling medium is drawn by the suction into the stator space through the at least one inlet opening and that the cooling medium is removed at the vicinity of both portions of the stator space.

Claim 8, upon which claims 9-12 are dependent, recites a method for an electric construction comprising a stator space defined by a shell and end portions at the either ends of the shell. A stator and a rotor of the electric machine are disposed within the stator space. Cooling medium is drawn into the stator space through at least one

cooling medium inlet opening in the shell intermediate the ends of the rotor by suction means for providing a suction. The suction means being provided at a vicinity of both end portions, the suction means are fans arranged at an interior side of the end portions of the stator space including rotor bearings, in which an outlet channel of said fans extends through the end portions, and the cooling medium is removed at the vicinity of both ends portions of the stator space.

Accordingly, the present invention provides a cooling arrangement and a method for cooling, wherein the overall temperature of the machine construction does not increase, and which enables a uniform cooling arrangement in a symmetrical manner. The present invention further provides an arrangement wherein the coolant is drawn in an axial direction, by an active suction into the center spacing of the arrangement. Subsequently, the coolant is discharged at both ends of the center spacing. This provides the advantages of having the coolant flow only half the way of the arrangement, and thus, remarkably improves the cooling efficiency.

It is respectfully submitted that the prior art fails to disclose or suggest the elements of the presently pending claims, and therefore, fails to provide the critical and non-obvious advantages which are provided by the present invention.

Purman discloses an electric motor cooled by a fluid such as a liquid refrigerant. The motor 10 is of the totally enclosed type having a cylindrical casing 30 enclosed at the ends by endwall 32 and compressor 12. Purman also discloses a rotor assembly 34 mounted within motor 10 and drives impeller 36 within compressor 12. A rotor shaft 38 is supported by a suitable bearing and bracket 40 mounted in casing 30 and by a similar bearing 42 adjacent to compressor 12. Rotor assembly 34 contains a plurality of rotor

laminae 44 attached in secured engagement to shaft 38. The rotor assembly 34 further includes a conventional squirrel cage motor winding having shorting end rings to which fan blades 46 to circulate the coolant may be attached axially. A tubular stator assembly 48 surrounds rotor assembly 34 and is formed of a plurality of cylindrical stator laminate 50. In addition, Purman discloses an annular chamber 60 for containing a coolant which is formed within motor 10 to embrace stator assembly 48. A coolant such as a liquid refrigerant is supplied to annular chamber 60 through pipe 66 which is connected to pipe 20. The motor 10 also contains end spaces 65.

Applicant respectfully submits that each and every element recited within claims 1 and 8 of the present application is neither disclosed nor suggested by Purman. In particular, Applicant respectfully submits that the electric machine construction recited in the present application is clearly distinct from that which is illustrated in Purman. Specifically, it is respectfully submitted that Purman fails to disclose or suggest at least one cooling medium inlet opening in the shell and positioned intermediate the ends of the rotor, and a suction means at the vicinity of both end portions of the stator space for providing suction for drawing cooling medium into the stator space, the suction means are fans arranged at an interior side of the end portions of the stator space including rotor bearings, in which an outlet channel of said fans extends through the end portions. Furthermore, it is submitted that Purman fails to disclose or suggest the arrangement in which the cooling medium is drawn by the suction into the stator space through the at least one inlet opening and that the cooling medium is removed at the vicinity of both portions of the stator space.

As mentioned above, Purman merely discloses a hermetically sealed motor-compressor arrangement for a refrigerator system or the like, wherein an external compressor 12 driven by the motor's rotor shaft 38 simultaneously is used for pumping an externally refrigerated liquid coolant into a space which is constituted by a casing 30. The coolant of Purman is conducted via an inlet 66 into an annular space 60 surrounding the motor's stator assembly 48 within the space defined by the casing 30. The annular space is connected via one or more centrally arranged vent arrangements 68 to a gap 56 between the stator assembly 48 and the rotor assembly 34. In the gap 56 of Purman, the coolant will flow axially outwards from the central portions of the motor into end spaces 65 formed within the motor casing 30. From the end spaces 65 the coolant will exit via a collecting hollow space (not separately referred to in the drawings) which is located under the motor casing 30 proper and from which a central outlet pipe 75 via an external cooling arrangement leads back to the compressor 12. Purman also briefly discusses an arrangement of fan blades 46 for circulating the coolant exiting from said gap 56 onto stator end turns 54 of stator windings 52.

In contrast to Purman, the motor according to the present invention is a high-speed solid rotor motor which is cooled by a gaseous medium, usually air. The motor of the present invention is never hermetically sealed, but a structure including a cylindrical shell body portion (8) and end shields (6) closing off the ends of the shell portion (8) and is arranged in a quasi sealed manner so that a flow of cooling air from outside the motor can be controlled in a desired manner. Thus, the coolant will flow into a stator space (9) essentially through inlet openings (14) which are expressly arranged in the shell portion (8) so that a stream of coolant (air) will be conducted into the stator spacing (9). In

order to effect such a cooling air flow into the motor of the present invention, a pair of fan means (13) are arranged at the inner side of the end shields (6). The fan means are directly attached to the rotor shaft (20) between the rotor and the rotor shaft bearings located within the end shields (6), and the outlet openings (12) from the fans (13) lead through the end shields (6) into open air either directly (see Fig. 2) or via a space (23) comprising heat exchanger means (24) (see Figs. 4a, 4b).

Given the above, Applicant respectfully submits that the motor arrangement of Purman is adapted for a liquid coolant (i.e. actually a cooling medium for a refrigerator arrangement, such as freon capable of transferring heat by means of a vaporization under impact of a source of heat energy and a subsequent re-condensation at a cooler arranged essentially at an ambient room temperature) and can not be adapted for a gaseous coolant. Additionally, it is respectfully submitted that the free flow of the liquid coolant is restricted, in Purman by special orifice rings 71 having flow rate control holes 73 therein. Furthermore, the utilization of a liquid coolant floating essentially freely in a high speed motor space is impossible, and thus, Applicant respectfully submits that Purman fails to disclose or suggest a motor arrangement that includes a totally gaseous coolant which is present both at the inlet and at the outlet portions of the motor housing.

Applicant submits that the present invention solves the problem of needing to force as high an amount of coolant as possible through the motor housing so that the cooling problem caused by the high power density of a high speed motor can be solved expressly by the use of a gas where the vaporization heat of the coolant cannot be utilized. In order to solve this problem, the present invention provides two suction action fans arranged one at each end of the motor housing, by means of which arrangement

the air convection within the motor housing is as efficient as possible while simultaneously preventing the temperature rise occurring at the fans from affecting the cooling process, since the air will be blown directly to the outside of the motor housing.

It is respectfully submitted that Purman fails to disclose or suggest the above. According to Purman, cooling liquid can be brought directly onto the stator end turns 54 via ducts 76, while the rotor includes traditional "end whisker means" which extend axially from the rotor's shorting end rings (see column 2, lines 45 and 46) and which direct a coolant flow through the stator end turns. These fans of Purman, however, do not function as the main circulating means for the coolant within the whole motor, but rather as local distributing means at the stator ends. Accordingly, the main coolant circulation of Purman is affected by a motor external working means, i.e. the coolant compressor 12 which further conveys the coolant to a heat exchanger located apart from the motor.

Contrary to that which is disclosed in Purman, the present invention discloses no such end fans attached to the shorting end rings. In fact, the fans of the present invention are arranged at a different location and they expressly act as the main distributing means. The use of an external fan means, especially for high speed motors, which would affect the pressure in the whole motor, is distinct compared to the motor disclosed in Purman. For instance, an underpressure within the motor space would "suck" oil from any oil lubricated bearings into the coolant circulation which can be very hazardous. In this respect, Applicant submits that Purman does not address the issue thereof, and merely discloses that the motor is fully sealed where no lubrication agent can emerge. Applicant submits that this distinction is very important

since the present invention addresses the question of preventing bearing lubricant from exiting the bearings, especially for high speed motors. It is respectfully submitted that the mere existence of such a problem is impossible in an arrangement according to Purman. On the other hand, by arranging the fans (13), as disclosed in the present application, on the rotor shaft inside the motor housing, as seen from the rotor shaft bearings, and further snugly close to the end shields (6) which hold the bearings, such a suction impact can be effectively eliminated.

Given the above arguments, Applicant respectfully submits that Purman fails to disclose or suggest each and every element recited within claims 1 and 8 of the present application.

With regard to claims 2-7 and 9-12, Applicant submits that each of these claims recites subject matter which is neither disclosed nor suggested by Purman. In particular, each of claims 2-7 and 9-12 depends from independent claims 1 and 8, respectively. Therefore, each of claims 2-7 and 9-12 incorporates each and every limitation recited within claims 1 and 8, respectively, therein. Therefore, Applicant submits that each of claims 2-7 and 9-12 also recites subject matter which is neither disclosed nor suggested by Purman for at least the reasons set forth above with respect to claims 1 and 8.

Claims 7 and 12 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Purman in view of Sheerin (U.S. Patent No. 5,844,333). In making this rejection, the Office Action took the position that Purman disclosed all of the elements of the claimed invention with the exception of a heat exchanger. Sheerin was cited as curing the deficiencies in Purman. Applicant respectfully traverses this rejection, and submits

that each of claims 7 and 12 recites subject matter that is neither disclosed nor suggested by the cited prior art.

Sheerin discloses a device and method for cooling a motor. A motor 100 is disposed in an enclosed motor frame 20. Sheerin discloses an ambient air fan 44 with a motor drive shaft 58. Disposed within enclosure 96 is a first air-to-air heat exchanger 24 having a plurality of coolant tubes 28. A first heat exchange 24 is disposed above a first end of motor 100 with coolant tubes 28 extending substantially transverse to the longitudinal axis of drive shaft 58. Also disposed within enclosure 96 is a second air-to-air heat exchanger 26 having a plurality of coolant tubes 34. The second heat exchanger 26 is disposed above a second, opposed end of motor 100 with coolant tubes 34 extending substantially transversed to the longitudinal axis of drive shaft 58.

Applicant submits that each and every element recited with each of claims 7 and 12 is neither disclosed nor suggested by Purman and/or Sheerin, taken alone or in combination. In particular, each of claims 7 and 12 depends from independent claims 1 and 8, respectively. Therefore, each and every limitation recited with claims 1 and 8 is also recited within claims 7 and 12, respectively. Therefore, claims 7 and 12 includes the limitations of at least one cooling medium inlet opening in the shell and positioned intermediate the ends of the rotor, and a suction means at the vicinity of both end portions of the stator space for providing suction for drawing cooling medium into the stator space, and wherein the arrangement is such that the cooling medium is drawn by the suction into the stator space through the at least one inlet opening and that the cooling medium is removed at the vicinity of both portions of the stator space. As mentioned above, Sheerin merely discloses a classically arranged cooling for a

traditional DC-motor and fails to disclose or suggest the above deficient limitations. Accordingly, Applicant respectfully submits that neither Purman nor Sheerin, taken alone or in combination, disclose each and every element recited within claims 7 and 12 of the present application.

In view of the above, Applicant respectfully submits that claims 1-12, each recites subject matter that is neither disclosed nor suggested in the cited prior art. Applicant also submits that this subject matter is more than sufficient to render the claims non-obvious to a person of ordinary skill in the art, and therefore respectfully requests that claims 1-12 be found allowable and that this application be passed to issue.

If for any reason, the Examiner determines that the application is not now in condition for allowance, it is respectfully requested that the Examiner contact by telephone the Applicant's undersigned attorney at the indicated telephone number to arrange for an interview to expedite the disposition of this application.

In the event this paper is not being filed, Applicants respectfully petition for an appropriate extension of time. Any fees for such an extension, together with any additional fees, may be charged to Counsel's Deposit Account No. 01-2300.

Respectfully submitted,
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Associate Power of Attorney
Petition for Extension of Time (Two Months)